THE EFFECT OF OVERBURDEN THICKNESS ON TENSION FRACTURE PATTERNS ABOVE AN UPLIFTING DOME

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Four experiments demonstrate that tension-fracture patterns above an uplifting dome depend on the thickness of the overburden layer being deformed. Four layers of increasing thicknesses (4.92 cm, 6.92 cm, 9.05 cm, and 11.12 cm) of a very fine sand (85%) and silt-clay (15%) mixture were updomed by slowly inflating a 1.22 m-diameter circular rubber pillow. The upper 2 cm of each layer was wetted and air dried to make it brittle and susceptible to fracture. The fractures that formed during these experiments exhibited a continuum of patterns from dominantly arcuate to dominantly radial as the overburden thickness increased. However, fracture density remained constant in each case for a given amount of surface deformation.

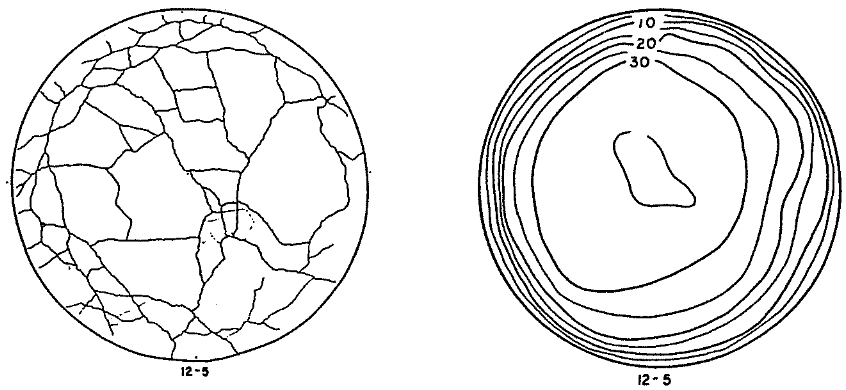
Features common to each experiment are (Fig. 1): 1) radial fractures at the edge of the dome; 2) arcuate fractures on the flanks of the dome and 3) a central zone where randomly oriented fractures result from tension in all directions. The outer radial fractures lengthened and the arcuate fractures formed nearer to the center of the dome as overburden thickness increased.

The spatial distribution of fractures changed drastically during the experiment. The highest fracture density was located near the perimeter of the dome in the thin layers (Fig. 1A, B), but it occurred nearer the center of the dome in the thicker layers (Fig. 1C, D). The surface deformation pattern explains this distribution. The strain is greatest near the perimeter with a thin overburden (Fig. 1A, B), but it is more uniformly distributed with a relatively thick overburden (Fig. 1B, C).

Salt domes on Earth and the Tharsis bulge of Mars provide excellent examples of radial faults due to updoming. Arcuate fracture patterns are associated with calderas and ring dikes. Playa lake fissures, the grabens of the Labyrinthus Noctis on Mars and many mudcracks often display a random orientation similar to the central zone of each experiment. These simple experiments show that distinctly different tension fracture patterns on domes depend on overburden thickness and strain distribution (Fig. 1).

Figure 1. Fracture patterns (left) and maps showing surface deformation in millimeters (right). Overburden thickness above the pillow is as follows: A) 4.92 cm, B) 6.92 cm, C) 9.05 cm, D) 11.12 cm.

A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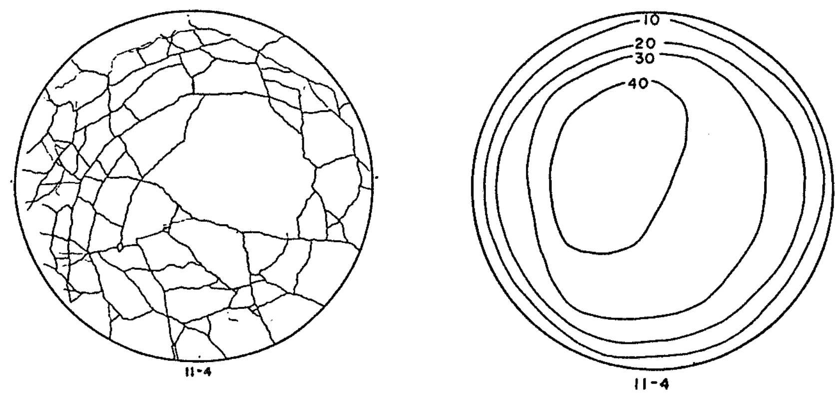
B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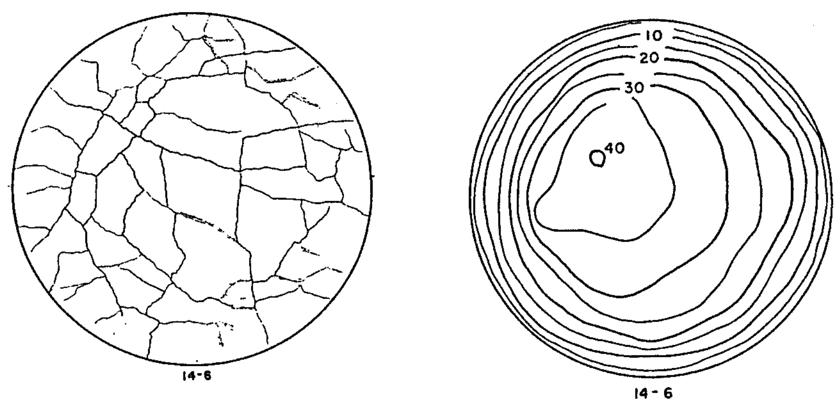
C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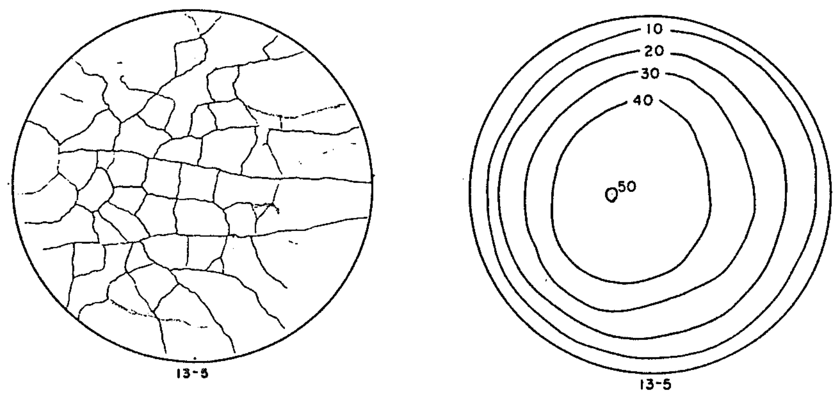
D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